ANSWERS: Describing & Explaining shapes

1. XeO_2F_2 is polar. It has 5 areas of electron density around the central Xe atom, one of which is a lone pair. Maximum separation for minimum repulsion means that the shape is based on a trigonal bipyramid structure, but is actually see-saw. The Xe=O bonds are polar, due to the greater electronegativity of O, and the Xe-F bonds even more polar, due to the F atom having the highest electronegativity on the periodic table. The molecule is not symmetrical, and so the dipole moments cannot cancel, making the molecule polar.

GeH_4 is non-polar. It has 4 areas of electron density around the central Ge atom, all of which are bonded. Maximum separation for minimum repulsion means that the shape is tetrahedral. This is a symmetrical structure, thus the bond dipole moments cancel, and therefore the molecule is non-polar.

2. 1. δ– δ+ 2. δ+ δ–
F---Cl At---Cl

3. There is a difference in electronegativity between S and F, so the S-F bonds are polar covalent. SF_4 has a see-saw shape (distorted tetrahedron) due to the repulsions between four bonding regions and one non-bonding region of charge, which is asymmetric therefore the polarities/dipoles do not cancel. As a result, SF_4 is a polar molecule.

There is a difference in electronegativity between Xe and F, so the Xe-F bonds are polar covalent. XeF_4 has a square planar shape, due to the repulsions between four bonding regions and two non-bonding regions of charge; therefore the polarities/dipoles do cancel. As a result, XeF_4 is a non-polar molecule.

4. Cl is more electronegative than P; therefore the P–Cl bond is polar in both molecules.
PCl_3 is a trigonal pyramid so this molecule is not symmetrical. This means that the dipole moments do not cancel and the molecule is polar.
PCl_5 is a trigonal bipyramid so the molecule is symmetrical. This means that the dipole moments cancel and the molecule is non polar.

5. ClF_3
Shape
- there are 5 regions of electron density around the Cl central atom
- these repel to take a trigonal bipyramidal arrangement / minimise repulsion / to get as far apart as possible
- there are only 3 bonding electron pairs / 2 lone pairs,
- thus forming a T-shape arrangement.

Polarity
- the Cl-F bond is polar because of electronegativity difference
- the molecule is NOT symmetrical
- bond dipoles do not cancel OR charge is not symmetrically distributed over the molecule,
- so the molecule is polar.

AsF_5
Shape
- has 5 electron pairs around the As central atom
- these repel to take a trigonal bipyramidal shape / minimise repulsion / to get as far apart as possible
- there are 5 bonding electron pairs / all electron pairs are bonding,
- thus forming a trigonal bipyramidal arrangement.

Polarity
- As-F bond is polar because of electronegativity difference
- molecule is symmetrical
- bond dipoles do cancel,
- so the molecule is non-polar.

6. IF_5
- polar IF bond due to difference in electronegativity between I and F
- molecule asymmetrical
- bond dipoles do not cancel/centre of +ve and –ve charges correspond
- molecule is polar.

PCl_5
- polar PCl bond due difference in electronegativity between P and Cl
- molecule symmetrical
- bond dipoles cancel / centre of +ve and –ve charges correspond
- molecule is non-polar.

7. XeF_4

Shape
- there are 6 electron pairs around the Xe central atom,
- these repel **to** take an octahedral arrangement / minimise repulsion / to get as far apart as possible,
- there are only 4 bonding electron pairs / 2 lone pairs,
- forming square planar arrangement.

Polarity
- the Xe-F bond is polar because of electronegativity difference,
- the molecule is symmetrical,
- polar bonds (NOT just bonds) cancel / centre of positive and negative charge correspond,
- so the molecule is non-polar.

SF_4

Shape
- has 5 electron pairs around the S central atom,
- these repel to take a trigonal bipyramid shape / minimise repulsion / to get as far apart as possible,
- There are only 4 bonding electron pairs / 1 lone pair,
- forming see-saw arrangement.

Polarity
- S-F bond is polar because of electronegativity difference,
- molecule is not symmetrical,
- polar bonds (NOT just bonds) do not cancel / centre of +ve and –ve charge do not correspond / polarities reinforce,

molecule is polar.

8. BrF_3: F is more electronegative than Br / electronegativity of two atoms different therefore the bonds are polar. The molecule is not symmetrical and this means that the dipole moments do not cancel polar bonds do not cancel / polarities of the bonds do not cancel / centre of + and – charges do not correspond so the molecule is **polar**.

SF_6: F is more electronegative than S / electronegativity of two atoms different so the bonds are polar. The symmetry of the molecule is such / molecule is symmetrical so that the dipole moments of bonds cancel / polar bonds cancel / or polarity of bonds cancel / centre of + and – charges correspond so the molecule is **non-polar**.

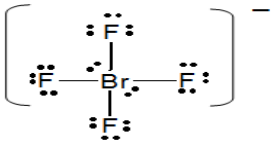
9. a) (i) tetrahedral **(ii)** square planar **(iii)** distorted tetrahedral / seesaw

A and B: symmetric
Polarities / dipoles / the effect of the polar bonds: cancel
Centres of positive and negative charge coincide
Symmetric / even distribution of charge about central atom.

C: asymmetric
Polarities reinforce centres of positive and negative don't coincide

Asymmetric/uneven distribution of charge about central atom.

C: asymmetric arrangement of polar bonds causes charge separation.



b)
Square planar
electron pairs repel
6 electron clouds /pairs of which 2 non-bonding / 4 bonding

c) Se
Shape requires, 5 electron pairs / 4 bonding pairs and 1 non-bonding pair
4 Se electrons shared with F's / 4 F electrons shared with Se (*may include structure as part of evidence for these*) 6 valence electrons on Z
Se
Need 5 electron pairs / clouds on central atom so total valence electrons must be 34. Total electrons from 4 F atoms is 28, (may include structure as part of evidence for these) so central atom must have 6 valence electrons

10. F different electronegativity than As: AsF bond polar.
AsF_3 is Polar
(Trigonal pyramid) molecule asymmetrical;
Polarities of AsF bonds reinforce
Centres of +ve and –ve charge do not coincide
Asymetric/uneven distribution of charge about central atom.

AsF_5 is Non - Polar
(Trigonal bipyramid) molecule symmetrical;
Polarities of AsF bonds cancel.
centres of +ve and –ve charge coincide
Symmetric/even distribution of charge about central atom.

11. BF_3 is non-polar.
B and F have different electronegativities so the B–F bond is polar covalent. The shape of the molecule (trigonal pyramid) is symmetrical about the central B atom, so bond dipoles cancel / add to zero to give no net dipole or symmetric distribution of charge about the central atom.

PF_3 is polar.
P and F have different electronegativities so the P–F bond is polar covalent. The shape of the molecule (trigonal pyramid) so the molecule is asymmetrical about the central P atom, so the P–F bond dipoles add to give a net dipole or there is an asymmetric distribution of charge about the central atom.